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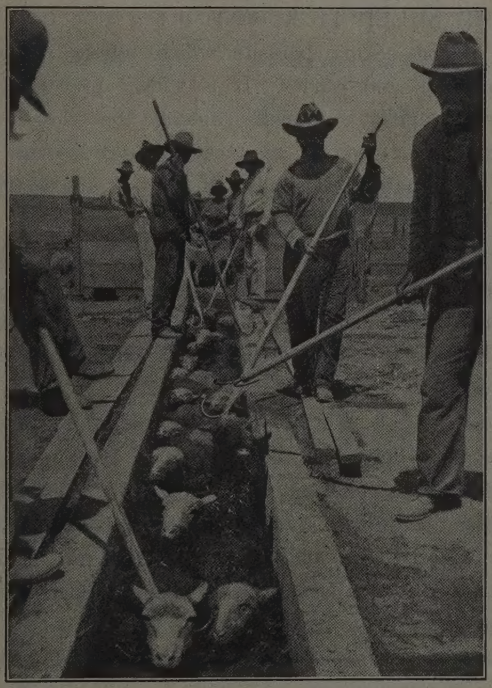
THE SHEEP TICK

AND ITS ERADICATION BY DIPPING

MARION IMES
Zoological Division



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THE SHEEP TICK, while not a true tick, is a blood-sucking parasite which infests sheep on both farms and ranges. It is widely prevalent and spreads rapidly, especially among the close-herded range flocks, where it may cause much damage and loss. The nature and habits of the tick are described, also methods of identifying it.

The only practicable way of destroying the pest is by dipping the sheep. Two dippings are necessary, about 24 days apart, as the first dipping may not destroy all the pupæ (eggs), and these may subsequently hatch a new brood.

Several kinds of dips are used successfully. Of the home-made dips the one found to be most efficacious is the lime-sulphur-arsenic dip. Full directions for making this dip are given in this bulletin. Methods of dipping large and small flocks are discussed, including plans of a wooden and a cement vat, showing details of construction.

THE SHEEP TICK AND ITS ERADICATION BY DIPPING.

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DISTRIBUTION AND ECONOMIC IMPORTANCE.

The sheep tick (*Melophagus ovinus*) is not a true tick but a wingless parasitic fly which passes the various stages of its life on the sheep. In many of the English-speaking countries it is known as the "ked" and is sometimes called the "louse fly" from its habit of living in the wool like a louse, but among the sheep growers of this country it is known as the sheep tick. It is widely distributed in many of the sheep-growing countries of the world, including the United States where it is known to occur in practically all of the States where sheep are kept. It is most prevalent, however, in the western range States where sheep are herded in large flocks. The northern two-thirds of the range country, or that part known as the Northwest, is the most heavily infested.

For a number of years it had been the custom in the majority of the principal sheep-growing States to dip the flocks regularly for scab. Such dipping evidently checked the spread of sheep ticks also, but as scab has been eradicated in many of the States compulsory general dipping for scab was discontinued in such areas, and especially in the Northwest. In the meantime the ticks spread rapidly and became prevalent in many of the flocks to such an extent that in some of the States compulsory general dipping was resumed in order to eradicate them. The sheep owners in some of the Southwestern States have continued to dip their flocks more or less regularly each season and consequently the ticks are not so plentiful in those areas. However, they are gaining a foothold in many of the flocks in this section, and conditions indicate that they may become a source of considerable loss if dipping is discontinued before they are eradicated.

Many of the farm flocks of the United States harbor sheep ticks and in some cases they are present in sufficient numbers to cause considerable damage to such flocks. This is especially true where open-fleece sheep are kept.

The sheep tick obtains its food by puncturing the skin of the sheep with its lance-like proboscis or sucking tube and feeding on the blood and lymph. The irritation thus caused is very great, especially in the case of lambs that are infested heavily, and while the quantity of blood drawn by one tick in 24 hours is small, the total amount taken by a large number of ticks is considerable and the drain constant. The irritation caused by the ticks makes the sheep restless so that they do not feed well, and in consequence, they do not grow and fatten as rapidly as when free from ticks. Thus a loss is caused by shrinkage in weight and a general unthrifty condition of infested flocks, with a consequent lowering of the vitality and a reduction in the resisting power of the animals. These conditions not only help to reduce the market value of the sheep but also tend to reduce wool growth, although being a bloodsucker, the tick does not feed on the yolk of the wool or directly injure the fibers to any great extent.

During the course of the investigations conducted by the Bureau of Animal Industry bearing on the problems of eradication, estimates of the average annual losses caused by sheep ticks were submitted by a large number of sheep owners in Utah. According to these estimates, the average annual losses are 25 cents per head for lambs and 20 cents per head for ewes in infested flocks. These figures are undoubtedly very conservative, as in estimating losses caused by parasites the indirect losses are seldom taken into consideration. Any factor operating to lower the vitality and resisting powers of domestic animals usually causes indirectly a considerable death loss during unfavorable seasons. The old saying, "Poverty breeds parasites," might with at least equal truth be read the opposite way, "Parasites breed poverty."

LIFE HISTORY.

The sheep tick, being a wingless fly, is in no way directly related to the true ticks. A true tick in the adult stage has 8 legs, while the so-called sheep tick has only 6 legs and in general form and structure is entirely different. (See fig. 1.)[1] Like other insects, sheep ticks vary in size, but the average length of adult females is about one-quarter of an inch. The life cycle of the sheep tick is divided into four natural stages or divisions, namely, the egg, the larva, the pupa, and the adult or sexually mature insect.

[1] Figures 1 to 8 are from photographs by Dr. W. T. Huffman, and the picture on the title page is from a photograph by Dr. George A. Lipp.

The egg is not laid, but is retained in the body of the female, where it develops into a larva in about 7 days. At the time of birth the larva is covered with a soft white membrane, which turns brown and becomes a hard shell, called a puparium, in about 12 hours. (See fig. 2.) The term pupa applies to that stage in the life of the sheep tick from the time it is born until it hatches into a young tick. During this stage the pupa remains within its hard shell or puparium, which is attached to the wool fibers by a glue-like substance which dissolves readily in water. These shell-covered pupæ are commonly called eggs. In from 19 to 24 days from the time it is deposited the shell of the pupa is broken open at one end and the young tick emerges and becomes active in the fleece. The time between the depositing of the pupa and the emergence of the young tick is usually called the period of incubation, and its duration is influenced by the temperature. During warm weather the average period of incubation is about 19 days, while during cold weather it is about

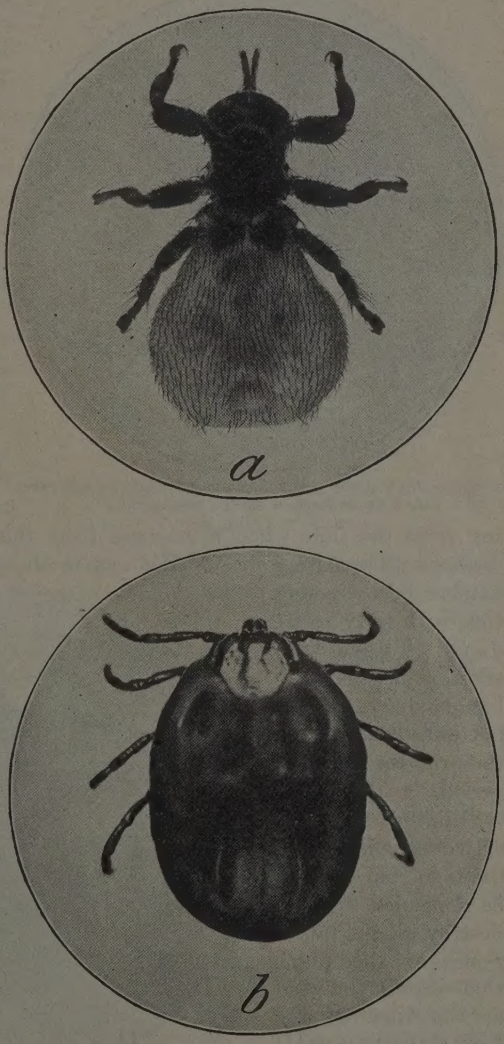

FIG. 1.—Comparison of form and structure of sheep tick and true tick. (*a*) Sheep tick (engorged female, enlarged); (*b*) true tick (engorged female, enlarged).

24 days, and in some cases longer. However, in practical operations under average conditions, 24 days has been assumed to be the longest period.

FIG. 2.—Pupa of sheep tick, commonly called the egg, taken from fleece of sheep; enlarged.

At the time the young tick emerges from the shell it is almost as large as a full-grown tick. (See figs. 3 and 4.) It develops very rapidly and reaches sexual maturity in 3 or 4 days. The female deposits her first pupa within 8 to 10 days after being fertilized.

The life history of the sheep tick, from the practical standpoint, may be summarized thus: Counting from the time when it emerges from the shell, the young tick deposits its first pupa or so-called egg in about 14 days. This pupa hatches into a young tick within 19 to 24 days. These two stages in the life history have an important bearing on the problem of eradication.

FIG. 3.—Young sheep tick emerging from the puparium; enlarged.

Dipping, if properly done, will kill all the ticks, but can not be depended upon to destroy all the pupæ. Some of the pupæ that were in the wool at the time of the first dipping will hatch, forming a new generation of ticks. This new generation must be destroyed by a second dipping before they have had time to develop and deposit pupæ. On the other hand, the second

dipping should not be done before all the pupæ which were in the wool at the time of the first dipping have had time to hatch, otherwise they may hatch after the second dipping and reinfest the flock. Consequently, it is important to allow a proper interval of time between the first and second dippings if the results are to be successful. The first dipping probably destroys many of the pupæ that are less than 4 days old, and the dip remaining in the wool has a tendency to prevent the development of young ticks and probably kills many of them. Under average conditions during early fall dipping, 24 days should elapse between the first and the second dipping.

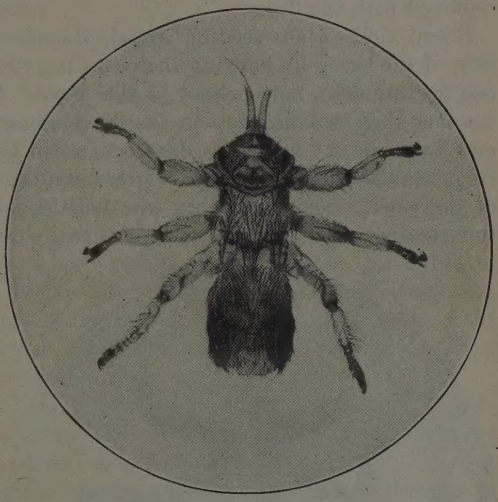

FIG. 4.—Young sheep tick just after emerging from the puparium; enlarged.

FIG. 5.—Mature male sheep tick, back view; enlarged.

NATURE AND HABITS.

True ticks, such, for example, as the Texas-fever tick, do not pass their entire life on the animal which they infest, but always drop to the ground to lay their eggs. The life history of the sheep tick is more simple. It does not drop off the sheep to lay eggs, but deposits its pupæ in the fleece. Each female deposits an average of from 12 to 15 pupæ during her lifetime, one being laid about every 7 or 8 days. These pupæ, or so-called eggs, are attached to

the wool fibers, usually from one-half inch to an inch from the skin. Consequently when the sheep are shorn the majority of the eggs are removed with the fleece.

Sheep ticks when feeding attach themselves temporarily to the skin of the sheep by burying their sucking tubes in the tissues; when not feeding they move about in the fleece. During cold, inclement weather they remain deep in the fleece close to the skin for shelter and warmth, but when the days are warm they are found near the surface and often can be seen in great numbers crawling over the tips of the wool. Sometimes they are dislodged from this position and thus temporarily infest trails, pastures, corrals, bed grounds, and premises. When dislodged from a sheep they crawl upon another at the first opportunity.

FIG. 6.—Mature male sheep tick, front view; enlarged.

The sheep tick does not transmit any known disease to the sheep, but it harbors a very small one-celled animal organism, related to forms which are transmitted by insects to various animals, including man, and which cause serious diseases.

Open-fleece sheep, such as the coarse-wool and medium-wool breeds, are subject to ravages by the tick. The fine-wool sheep usually are not affected to any great extent, as the parasites do not seem to be adapted to existence in the greasy, tight fleeces of such breeds. When the flock is heavily infested the ticks may be found on any part of the body, but they usually select locations where the wool is thin and occur in greatest numbers on those parts where they are protected from the efforts of the sheep to dislodge them. The neck, breast, shoulders, belly, and thighs are the favorite locations.

Many of the ticks are removed with the fleeces at the time of shearing, especially if machine shearing is practiced. The freshly shorn sheep offers very little protection for the ticks, and consequently, during the shearing season, the ticks migrate to the lambs in large numbers. The lambs of the flock suffer most from the ravages of

this pest, and if they become heavily infested receive a setback at an important period in their development, thus causing considerable financial loss to the owner.

SPREAD.

Although sheep ticks do not seem to possess the instinct of migration to any great extent, nevertheless, once introduced into a flock, they spread rapidly until the entire flock is infested. As range sheep are usually close herded, crowded into corrals, and come into close contact on the bed grounds, the ticks pass readily from one animal to another. On farms, where the sheep are not close herded but graze in fenced inclosures, the conditions are not so favorable to rapid spreading; but during cold weather, when such sheep are placed in corrals, sheds, or barns, in close contact, every member of the flock as well as the premises will almost certainly become infested if there are ticks on any of the sheep.

While sheep ticks will not propagate or even live for any considerable time on other animals than sheep,[1] they may be harbored temporarily by dogs or other animals which have come in close contact with an infested herd. Men working among infested sheep may carry the parasites on their clothing and thus be the means of introducing them into clean flocks. If separated from the sheep the ticks do not live longer than about 4 days, as a rule, and it might be assumed that places from which all sheep had been removed would become free from sheep ticks within a very few days. However, the survival of dislodged ticks is not the only factor influencing the length of time premises may remain infested after the removal of infested sheep. Tags of wool to which pupæ are attached may be pulled out by bushes, fences, etc., or by the sheep themselves. If the weather is warm and other conditions favorable these pupæ will hatch and infest the premises.

Under ordinary conditions the period of incubation is from 19 to 24 days and in some cases longer, the length of the period being influenced by temperature and other factors. Laboratory experiments have indicated that the incubation period of pupæ removed from sheep may be as long as 46 days. Infested sheep, in their efforts to obtain relief from the irritation and itching, may dislodge some of the ticks and eggs. The ticks will die in a few days, but if conditions are favorable the pupæ or eggs will retain their vitality and hatch in due time. The pupæ dislodged from the sheep during cold weather or when the nights are frosty will not

[1] Experimental data seem to indicate that sheep ticks may live and propagate on goats. Dr. E. R. McClure placed 12 ticks on an Angora goat and held the goat under observation for 60 days. The ticks lived and propagated during this period, at the end of which time the goat was returned to the flock and observations were discontinued.

hatch, but will be destroyed. It seems reasonably certain that freezing temperature will destroy the vitality of the pupæ. These facts have an important bearing on the problem of eradication. Premises or places occupied by ticky sheep may become infested, and if conditions are favorable for the development of the pupæ they may remain infested for a period of from 45 to 50 days from the time ticky sheep were removed. A seemingly safe basis of practice during warm weather would be to consider all premises occupied by ticky sheep as infested for a period of 60 days from the date of infestation. During cold weather, when the temperature drops to freezing at any period during the day or night, infested premises probably would become free from infestation within a day or two, except in places well protected from the cold, such as sheds and stables.

During warm weather infested corrals or inclosures should not be used for clean sheep. If it is necessary to use such corrals they should be cleaned and disinfected by removing all litter and manure, cleaning down to a smooth surface, after which the floors and sides should be sprayed with a good disinfectant. The coal-tar-creosote dips diluted to double the strength recommended for dipping are suitable for this purpose. The cleaning should be done carefully in order that all pupæ may be removed with the litter, as the disinfectant probably will not destroy the vitality of the pupæ. All litter and manure from infested premises should be spread on the ground and plowed under or disposed of in such manner that sheep can not come in contact with it for at least 60 days. An economical and effective method of disinfecting stone or wire fence corrals is to scatter straw or brush over the surface of the ground and burn it. If the brush or straw is dry so it will burn readily sufficient heat will be produced to destroy the parasites.

DETECTING TICKS IN THE FLOCK.

When sheep are heavily infested with ticks they bite and scratch and rub against any available object, including other members of the flock. The natural position of the wool is disturbed by these efforts to obtain relief from the intense itching; more or less wool is pulled out, and the fleece may have a ragged appearance. (See fig. 7.)

If sheep ticks are causing the trouble, they may be found by parting the wool over the neck, breast, shoulders, belly, and thighs. They are large enough to be seen readily and are of a brownish color. On warm days they often may be observed crawling over the tips of the wool. If ticks are present pupæ usually will be found attached to the wool fibers. These are seen easily with the naked eye, being about one-eighth of an inch in length. Their color varies from yel-

lowish white to dark brown, and the shell is glossy and firm. (See fig. 8.)

Any condition which causes the sheep to bite and scratch themselves may be mistaken temporarily for ticks. In every instance close examination should be made and the cause definitely learned. It

FIG. 7.—Lamb grossly infested with sheep ticks, showing roughened condition of fleece.

should be remembered, however, that the presence of ticks does not exclude other possible causes of the irritation, such as scab, lice, common ticks, bearded seeds, thorns, etc.

ERADICATING THE TICKS BY DIPPING.

Dipping consists of immersing the animals in a medicated liquid that will kill the parasites, and is the only practicable method known for eradicating sheep ticks. The process of dipping is shown in the illustration on the title page. In order that the medicated liquid or dip may exert its killing powers it is necessary that it come in direct contact with the tissues of the parasite. There are three methods by which the dip may enter the organism of the tick; first, ingestion, by way of the mouth parts, through the digestive organs; second, respiration, by way of the stigmata or breathing pores, through the respiratory organs; third, absorption, through the skin by a process of osmosis. The nonvolatile dips, such as the arsenic group, are prob-

ably taken in largely by ingestion and to a less extent by absorption, and kill through cumulative action of the poison. The nicotin dips are probably taken in mainly by absorption and to a less extent by ingestion and respiration. The coal-tar-creosote and cresylic-acid dips give off gases and are taken in mainly by respiration and possibly to a less extent by absorption. It is seemingly not a mere question of bringing the parasite into temporary contact with the dip, as the period of time during which the poison exerts its action is an important factor. Very few of the known dips will kill the parasite immediately; therefore the length of time the sheep are held in the vat is not the sole determining factor, provided they are held in the dip a sufficient length of time to saturate the fleece. The length of the wool, the quantity of dip retained in the fleece, the length of time that the dip remains active in the wool, and the nature

FIG. 8.—Close view of portion of neck of lamb shown in figure 7, showing ticks and pupæ in wool.

of the active principle, all have an important bearing on the results. Other factors being equal, the dip that remains longest in the wool and retains its killing power for the longest period is most desirable, not only for destroying the parasites on the animal but also for preventing reinfestation.

In dipping sheep for ticks the entire flock, together with all goats, dogs, or other animals which may have been with the sheep, should be dipped regardless of the number showing infestation. The fleece should be saturated thoroughly, but as there are no crusts or scabs to be penetrated, it is not necessary to hold the animals in the vat longer than about 1 minute. The head of each animal should be submerged at least once and care taken that every part of the fleece is wet. As only coarse-wool and medium-wool sheep usually become infested heavily, and as such fleeces are penetrated easily by the dip, it is not considered necessary to maintain the dip at a high temperature. However, it should not be cold enough to chill the animals; the range should be between a minimum of 65° F. and a maximum of 95° F. The temperature of the dip should be ascertained accurately by using a thermometer. If a proprietary dip is used the printed instructions on the label of the container should be followed both as to the time the animals are to be held in the dip and the temperature at which the dip is to be used.

The season best suited for dipping to eradicate ticks depends upon the altitude, the climatic conditions, and the methods of handling the sheep. In those sections where spring shearing is practiced, July and August are considered the best months for dipping. If the lambs become heavily infested shortly after shearing, which often occurs, the flock should be dipped as soon as the shear cuts heal. One objection to dipping too soon after shearing is that the wool is short and the fleece will not retain much of the dip. For this reason fall dipping probably would prove more effective than summer dipping in eradicating ticks. It is advisable, however, to dip at about the same time that the neighboring flocks are dipped in order to lessen the chances of reinfesting the neighborhood.

If the dipping is to be successful, it is necessary to give close attention to the details and to see that the work is performed carefully and thoroughly. Sheep should not be dipped immediately after shearing; a period of at least 10 days should elapse between shearing and dipping, in order that the shear cuts may heal. It is dangerous to dip sheep in some of the dipping preparations if there are any fresh wounds on the animals; consequently, dogs that bite the sheep should not be allowed in the dipping corrals. The chutes, pens, and dipping vat should be examined closely for nails, broken boards, or any object that may puncture or wound the skin of the sheep. Animals having fresh wounds when dipped in some of the dips usually develop a

condition commonly known as "blood poisoning," and the mortality from this cause is high. After the wounds have granulated or healing is well started there is little or no danger from this source. Rough handling of the sheep at the time of dipping results in more harm and damage to the flock than is caused by the dip. When sheep are placed in the dipping vat by hand, the men handling them should be instructed to do so carefully. They should not be allowed to catch the sheep by the ears; this is sometimes done, and has resulted in breaking or bruising the skin, causing the heads to swell after dipping, and resulting in considerable death loss.

Ewes and lambs should not be dipped together; if put into the vat at the same time the danger of drowning some of the lambs is much greater than when they are dipped separately. The lambs should be "cut out" and dipped separately, and they need not be held in the swim as long as the older sheep. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this, however, is probably not correct. A ewe recognizes her lamb by smell and not by sight, consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However, the members of the flock will adjust matters for themselves, and, as a rule, practically every lamb will be recognized by a mother. It often happens that an undipped sheep will jump out of the pens and get in with those that have been dipped. This should be carefully guarded against and all such sheep dipped before the flock leaves the vat.

Prior to bringing the sheep to the vat for dipping they should be watered and fed so as not to be thirsty or hungry at the time of dipping, although they will probably stand the effects of dipping better if not too full of feed and water at the time dipped. If they are watered and fed 3 to 6 hours before dipping they are likely to be in the best condition for the operation. When the weather is cold or stormy dipping operations should be commenced early in the morning and finished for the day in time to give the last sheep dipped opportunity to dry off before night. During winter weather dipping for the day should be finished by noon, so that the flock may have time to dry off and fill up with feed before night, as a sheep with a full stomach will withstand much cold and hardship. If these precautions are observed sheep may be dipped with reasonable safety during cold weather.

Bucks should be dipped separately from ewes and lambs. They should not be driven fast and then put into the vat before resting and cooling off. As they succumb very easily in the vat, it is necessary to give them careful attention. At the large vats the buck herds usually are dipped first, while the vat is full, so as to afford them more swimming room.

DIRECTIONS FOR DIPPING.

The quantity of dip in the bath should be sufficient to submerge the sheep completely; that is, the depth of the dipping fluid in the vat should be not less than 40 to 48 inches, depending on the size of the sheep. The quantity of fluid necessary to fill the vat to the required depth should be ascertained before it is prepared. Freshly shorn sheep and short-wool lambs will carry out on an average from 1 to 2 quarts of dip, depending on the size of the sheep and the length and grade of wool, while full-fleeced, fine-wool sheep will carry out and retain in the fleece as much as 2 gallons. At late fall dipping the average medium-wool sheep will retain in the fleece about 1 gallon of dip. In estimating the quantity of dip required, these facts should be taken into consideration. After computing the quantity of dip required to charge the vat, the average quantity which each sheep will carry out should be estimated; this should be multiplied by the number of sheep to be dipped, and the product so obtained added to the quantity required to fill the vat. If the vat and draining pens are water-tight, so that no dip is lost through them, the total as given above should show the approximate number of gallons of dip required to complete the work.

FIG. 9.—Stirring plunger for mixing liquids in the vat.

After the vat is filled to the required capacity the contents should be well mixed by stirring, in order that the temperature may be uniform throughout. A good method of stirring the dip in large vats is to take a 5-gallon pail or dip container, punch holes near the top, insert a wire for a bail, allow the can to fill and partially sink, then drag it with a dipping fork rapidly from one end of the vat to the other, and repeat the process until the temperature is uniform, as shown by taking it at several points in the vat. Stirring plungers are useful implements, and, as they are easily made, one or more should be provided at every vat. They are used in a manner similar to the movement of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat. The style shown in figure 9 is the one most commonly used.

The dip should be changed as soon as it becomes filthy, regardless of the number of sheep that may have been dipped in it. In emptying the vat the entire contents should be removed, including all sediment and foreign matter. After the liquid portion has been dipped

out or drained off, the sediment and dirt at the bottom should all be removed and the bottom cleaned by sweeping or scraping with a hoe or spade. After lime-sulphur-arsenic dip has been mixed to the proper strength for dipping and used in the vat, it should not be used again after it is 10 days old. This is a safe rule to follow with any of the sheep dips, as losses often occur from dipping in old or stale dips.

The drowning of sheep in the vat can be avoided by proper care. Men with dipping forks should be stationed along the vat on both sides to attend the sheep and prevent accidents. When the vat becomes filled with sheep their progress is retarded and they frequently attempt to raise themselves out of the dip by placing their forefeet on the back of the sheep in front. The men along the vat should prevent this by keeping the sheep properly arranged in the vat. The dipping forks should be used to keep all of the sheep's body submerged except its head while it is passing through the vat; this can be done by placing the dipping fork over the shoulders of the sheep and gently but firmly pushing it under the dip. The animal will raise its nose so that the neck and part of the head can be submerged without danger of strangling. Old ewes that have been dipped a number of times are sometimes difficult to handle, both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they will make efforts to regain this position and may strangle. Sheep that are affected by eating loco weed often drown in the vat unless they are piloted through. When strangling occurs the sheep should be taken from the vat. If it does not get upon its feet, pull the tongue forward, dash cold water over the head and body, and if necessary, induce artificial respiration. When it has regained sufficient strength, and if it has not been in the dip long enough, the animal should be returned to the pens and piloted through the vat again.

FIG. 10.—Two styles of dipping forks.

DIPPING FORKS.

In using large vats dipping forks are necessary for the efficient handling of the sheep and should be provided as a part of the equipment at every plant. Several different styles are made, but the two shown in figure 10 are the ones commonly used. The one with both hooks turned upward seems to have the preference for the reason that when it is in use either side may be hooked under the neck of the sheep for raising the head in case of strangling. The handles should be strong and from 5 to 6 feet long. The hooks should be

made of half-inch round iron and firmly held in the handle by an iron ferrule. These forks can be bought ready-made or may be made by any blacksmith.

EXPENSE OF DIPPING.

The cost of dipping naturally varies in different sections; it also varies in the same section, depending on the number of sheep to be dipped, the location relative to the necessary supplies, and the facilities available for the work. The labor, fuel, and cost of materials are the three principal items of expense. In the sheep-growing sections of the West the average cost of dipping sheep varies from 2 to $3\frac{1}{2}$ cents a head for each dipping.

WATER FOR DIPPING PURPOSES.

Water is so good a solvent that it dissolves and holds in solution large quantities of the various mineral salts. Waters containing such salts are commonly spoken of as being "brackish," "hard," or "alkali," depending upon the amount and character of the mineral matter contained. Much of the water on the semiarid ranges of the West is hard or alkaline and not suitable for diluting all kinds of dips. The thickly settled farming communities, being located in areas of greater rainfall, do not experience so much difficulty in finding a supply of reasonably good water. However, hard or alkaline waters are found more or less frequently in all parts of the United States, and where it is possible to do so their use for dipping purposes should be avoided for two reasons: First, to lessen the possibility of injury to animals; second, to increase the wetting powers of the dip and consequently the curative effects.

The wetting power of a dip is influenced by several factors, but observations indicate that when soft water is used for diluting dips the fluid has greater wetting power than when some of the hard waters are used. The term "beading" is commonly used in connection with dips of low wetting power. Such dips have a tendency to form in small bead-like drops over the wool instead of spreading in a film around each wool fiber and becoming evenly distributed over the entire exposed surface. By increasing the wetting power of the dipping fluid its efficiency is enhanced, because the active principle is more evenly distributed and all exposed parts receive the maximum possible wetting. Experience has demonstrated that good dips sometimes are rendered ineffective by being diluted with alkaline water.

Before diluting coal-tar-creosote or cresol dips with hard or alkaline water, a test should be made to determine whether a separation occurs in such water. In a clean bottle or jar of clear glass place a

measured quantity of dip, and pour in, with thorough mixing, the desired quantity of the water, preferably warm, which should be added in approximately the proportion to be used in dipping. If after standing for one hour an oily layer or mass of globules appears either at the top or at the bottom of the liquid, the dip should not be used with that kind of water.

Sheep dips are most effective when used with soft water. If it is necessary to use alkaline water for diluting such dips, the water may be "broken" by using sal soda in the proportion of from 1 to 4 pounds for each 100 gallons of water, depending upon the "hardness" of the water. Where the water intended for dipping purposes is very impure the owner should have it analyzed and obtain the advice of a competent chemist on methods of correcting the water to render it suitable for diluting the dip he proposes to use.

KINDS OF DIPS.

In choosing a dip for sheep ticks the conditions under which it is to be used should be considered. A dip that might be best under one set of conditions is not necessarily so under all conditions. The nature of the dip and its effect on the animals when used with the water available at the dipping plant should be considered. If the dipping plant is not supplied with soft water the dip that works best in the water available should be selected. Dips deteriorate by use; that is, after a number of sheep have passed through the vat the active principle of the dip falls below the standard required for effective work. For example, during investigations in the Bureau of Animal Industry 35 lambs in 4 groups were dipped in a vat containing 60 gallons of diluted cresol U. S. P., 1 part to 100 parts of water. Samples were taken before and after dipping each group. These samples were analyzed, with the following results:

	Per cent cresylic acid.
No. 1, taken before any lambs were dipped	0.45
No. 2, taken after 9 lambs were dipped	0.34
No. 3, taken after 18 lambs were dipped	0.26
No. 4, taken after 27 lambs were dipped	0.18
No. 5, taken after 35 lambs were dipped	0.12

The difficulty has been overcome for some of the dips, and the Bureau of Animal Industry now supplies its inspectors with portable testing outfits for testing the dip at the vat. The only dips for which portable testing outfits are available at present are the arsenic, the nicotin, and the lime-sulphur.

Certain groups of ready-prepared dips are efficacious and have been used by flock owners with a fair degree of success. Among these may be mentioned the coal-tar-creosote, the cresol, and the nicotin dips. The only homemade dip which has proved efficacious is the

lime-sulphur-arsenic dip. This dip probably will eradicate sheep ticks with one dipping when all conditions are favorable, but one dipping can not be depended upon in practical operations. It will undoubtedly eradicate ticks if the flock is given two dippings, and it has the advantage that it may be used in almost any of the hard waters without injury to the animals from that cause. Its disadvantages are that there is no test by which the rate of deterioration may be determined in the field and that it is more difficult to prepare than some of the other dips. None of the dips tried in the bureau's investigations can be depended upon to eradicate sheep ticks with one dipping.

COAL-TAR-CREOSOTE DIPS.

The coal-tar-creosote dips are sold under a large number of trade names. They are made from coal-tar derivatives and the principal ingredient is so-called creosote oil, which is made soluble in or miscible with water by means of soap. When diluted with suitable water they are very efficacious in eradicating sheep ticks from a flock if two dippings are given with an interval of 24 to 28 days between dippings. There is no field test for determining the deterioration of these dips, and consequently in replenishing the dip the percentage of active principle in the vat is largely a matter of guesswork.

These dips should contain, when diluted ready for use, not less than 1 per cent by weight of coal-tar oils and cresylic acid. In no case should the diluted dip contain more than four-tenths of 1 per cent nor less than one-tenth of 1 per cent of cresylic acid; but when the proportion of cresylic acid falls below two-tenths of 1 per cent the coal-tar oils should be increased sufficiently to bring the total of the tar oils and the cresylic acid in the diluted dip up to 1.2 per cent by weight.

In the undiluted coal-tar-creosote dips, especially in cold weather, a separation of naphthalene and other constituents of the dip may occur. Care should therefore be taken to see that the dip is homogeneous in character before using any portion of it.

CRESOL DIPS.

The cresol dips are sold under various trade names, and consist of a mixture of cresylic acid with soap. The term cresylic acid as used in this connection covers those cresols and other phenols derived from coal tar, none of which boil below 185° C. (365° F.) nor above 250° C. (482° F.). When diluted ready for use a cresol dip should contain one-half of 1 per cent of cresylic acid. As there is no field test available for cresol dips, the rate of deterioration can not be determined at the vat, and consequently after a few sheep have been dipped there is no method known for keeping constant the percentage of cresylic acid in the used dip.

When used with suitable water these dips are very efficacious in eradicating sheep ticks, if the flock is given two dippings 24 to 28 days apart.

Coal-tar-creosote and cresol dips should always be tested on a small scale, as outlined on page 17, to avoid injury to the sheep as far as possible. However, death losses may occur even when there is no apparent separation in the dips when tested under this method. Special care in this connection is necessary where hard water is used.

NICOTIN DIPS.

The nicotin dips are sold under various trade names, and the flock owners are more or less familiar with them from use in dipping for scabies. When used in seven-hundredths of 1 per cent solution they will eradicate sheep ticks, if two dippings are given with an interval of from 24 to 28 days between dippings. A field test has been designed by one of the large manufacturers of nicotin dips so the percentage of nicotin in the dip may be ascertained at the vat side at any time. These dips should be used in accordance with the instructions printed on the label of the container.

THE LIME-SULPHUR-ARSENIC DIP.

The lime-sulphur-arsenic dip is made by mixing standard strength lime-sulphur dip with one-half standard strength arsenical dip. Directions for making lime-sulphur dip and the arsenical dip and mixing the two to form a dip for sheep ticks are as follows:

The lime-sulphur dip is made in the proportion of 8 pounds of unslaked lime (or 11 pounds of commercial hydrated lime, not air-slaked) and 24 pounds of flowers of sulphur or sulphur flour to 100 gallons of water. Place the lime in a water-tight, shallow box and add sufficient water to form a thin paste. Sift the sulphur into this and mix well until a paste of about the consistency of mortar is formed, adding water as required. Place this lime-sulphur paste in 30 gallons of boiling water and boil for 1 hour, adding water from time to time to maintain the quantity at 30 gallons or in that proportion. During the boiling process the mixture in the boiling tank should be stirred well to prevent the paste from settling and caking on the bottom of the tank; the boiling process should be continued until all sulphur disappears from the surface. A large mortar hoe is a good implement with which to stir the boiling mixture. The lime and sulphur should both be weighed; do not trust to measuring them in a pail or guessing at the weight. It sometimes happens that the sulphur is not all "cut" or dissolved; this is especially true if the lime is not of first-class quality. Small quantities of extra lime may be added if during the cooking it is noted that the sulphur is not being "cut" properly. As an excess of lime in the dip will tend

to injure the sheep and the wool, no more lime should be added than is necessary to cut the sulphur. After the mixture has been boiled for 1 hour the liquid should be of a chocolate or dark amber color.

The contents of the boiling tank should be drawn off or dipped out and placed in the settling tank and allowed to stand until all sediment has settled to the bottom and the liquid is clear. The use of some sort of settling tank provided with a bunghole is an absolute necessity, unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary water-tight barrel will answer very well for a settling tank at small vats. All settling tanks of every nature should have an outlet at least 4 inches from the bottom, in order that the clear liquid may be drawn off without becoming mixed with any of the sediment (see fig. 11). Drawing off the liquid as above indicated has an advantage over dipping it out, for the reason that in the latter case the liquid is stirred more or less and mixed with the sediment. The prime object is to get the clear liquid without any sediment. The sediment should under no circumstances be allowed in the dipping vat, as it will injure the wool and the eyes of the sheep.

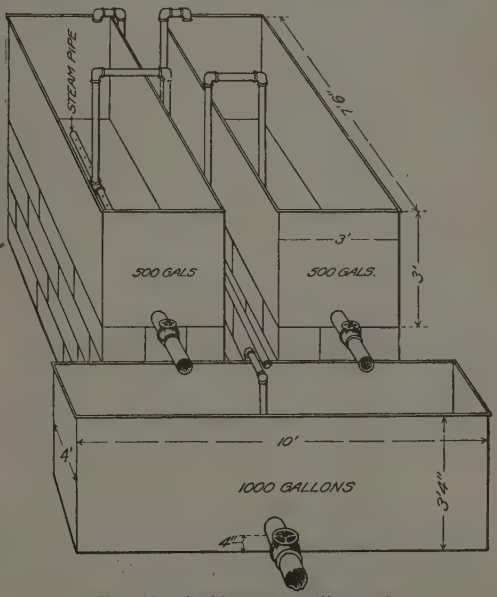

FIG. 11.—Cooking and settling tanks.

When the sediment has fully settled, draw off the clear liquid into the dipping vat and add warm water sufficient to make a total of 100 gallons of dip. When mixed and cooked as above specified the concentrate is three and one-third times the strength required for the dip in the vat, so that to every 30 gallons of such concentrate 70 gallons of warm water should be added to make a dip of the required strength.

In preparing lime-sulphur dip in large quantities, several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity

enough lime-sulphur paste should be cooked at one time to dip the flock. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

To each 500 gallons of lime-sulphur solution prepared and diluted as above directed add 4 pounds of arsenic[1] and 12 pounds of sal soda made into a solution as follows: Put 12 gallons of water in a kettle or tank, heat to boiling, and add 12 pounds of sal soda; when this has been dissolved add 4 pounds of powdered white arsenic, then boil and stir for 15 minutes or longer, until the white arsenic has entirely disappeared. The quantity of arsenical solution prepared at any one time is limited only by the capacity of the kettle or tank, but the proportions of the ingredients should not be altered. The arsenical solution should be added to the diluted lime-sulphur solution in the vat. When the arsenical solution is added a yellow-colored flocculent precipitate is formed which remains in suspension. The liquid in the vat should be well stirred before dipping operations are commenced. This dip can be used in any kind of water without injury from the water, but there is no field test for its strength.

It should be remembered that this dip is poisonous, and due precaution should be taken in handling and using it. The sheep should be held in the draining pens and holding corrals until all surplus liquid has drained from the fleeces. When the vat is emptied the dip should be disposed of in such manner that the animals may not have access to it. Preferably it should be run into an inclosed pit.

INJURY FROM DIPPING.

Dipping often results in a slight setback to the sheep. There may be a temporary shrinkage in weight or constitutional disturbances, or both. Various factors operate to produce these conditions. They may occur with any of the standard dips, but should not always be attributed to the effects of the dip alone. The age and physical condition of the sheep, the method of handling the flock at the vat as well as before and after dipping, the character of the water used, the method of preparing the dip, and various other factors should be considered before placing the blame on the dip. Young animals in a thriving condition recuperate very rapidly from any temporary ill effects; while old, weak, or emaciated animals succumb very readily and regain lost weight slowly. Injury caused by dipping is more likely to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling of sheep in the corrals and legging pens; dipping the flock immediately

[1] Farmers' Bulletin 603 contains directions for making arsenical dip.

after a long, hard drive before they have rested and cooled off; dipping late in the afternoon when the nights are cold; keeping the sheep without feed and water for long periods before and after dipping; using dogs in the corral; and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury. However, some of the dips if used in unsuitable water may cause injury, and any of them when used too strong will injure the sheep.

The question often arises as to the proper age at which lambs should be dipped to get the best results and cause the least damage. It is perfectly safe to dip the flock when the lambs are not less than 1 month old, provided the lambs are dodged out and dipped separately. Any slight shrinkage caused at this time will be regained quickly and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by the ticks. If the work is done properly and the sheep handled carefully, pregnant ewes may be dipped with safety at any time up to within one month of lambing.

DIPPING PLANTS.

EQUIPMENT FOR SMALL FLOCKS.

The farmer who has but a small flock to dip can use a portable galvanized-iron vat as shown in figure 12, turning a part of his barnyard or sheds into catch pens for temporary use. The portable galvanized-iron dipping vats, called "hog vats," can be purchased ready-made and will answer the purpose very well for dipping small lots of farm sheep. They are sometimes set on the surface of the ground and the sheep lifted into them, but this method is not very satisfactory. An excavation should be made, the dimensions of which exceed slightly the outside dimensions of the vat, except the depth, which should be less, so that when the vat is set in the trench the top may extend about 6 inches above the surface of the ground. Approaches and draining and holding pens may be provided as desired.

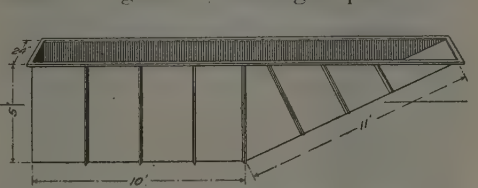

FIG. 12.—Portable galvanized-iron sheep dipping vat.

A canvas dipping bag (fig. 13) is used sometimes when only a few sheep are to be dipped at different points in a given section, as it has the advantage of being easily transported. It is made of heavy canvas, known in the trade as No. 40, and is constructed as follows: Two strips of canvas 8 feet long and 26 inches wide are sewed together to form a bag 48 inches deep and 94 inches in circumference. Seams are triple sewed and top and corners reinforced with leather

strips riveted on. Iron rings held by leather ears are riveted to the upper part of the bag as shown in the illustration. The bag is filled with dip, diluted as for use in a dipping vat, the sheep's feet are tied, and the animal is set down in the bag and held the required length of time.

Heating tanks or boilers are necessary, the size varying with the number of sheep to be dipped. An ordinary iron caldron or kettle will answer the purpose for a small number of sheep. A rectangular galvanized-iron tank with large heating surface is preferable. Such a tank is set on two parallel walls, the walls forming the sides and the bottom of the tank forming the top of the fire box. An opening large enough for the escape of the smoke should be provided at the end opposite that at which the fire is fed.

FIG. 13.—The canvas dipping bag in use.

A PERMANENT DIPPING PLANT.

When large flocks are to be dipped or when a farmer is in the sheep business permanently, it is necessary to provide proper facilities for the work and a permanent dipping plant is the only practical solution. It should be constructed and equipped so that it will be suitable for use in dipping sheep for scab as well as for ticks and other parasites.

SELECTING A LOCATION.

In selecting a location for a dipping plant the fact that sheep work better upgrade should be considered and, if possible, the ground used for the receiving corrals and chute should slope up to the end of the vat. The vat itself should be on level ground and preferably extend

north and south, with the entrance at the south and the exit at the north, as it has been observed that sheep work better also when not facing the sun. If the ground selected has good natural drainage, it is a point in favor of the location.

CORRALS AND CHUTES.

In constructing a dipping plant the arrangement of the corrals is important. The receiving corrals, into which the sheep are driven preparatory to dipping, as well as the holding corrals, into which they go from the draining pens, each should be large enough to hold a full band of sheep, or about 3,000 head. The receiving corral should be constructed so that there may be the least practicable number of corners or places in which the sheep may become jammed or "piled up."

In an effort to get out a sheep will try to go back to the place where it entered the corral; therefore, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be so arranged that a combination legging pen and running chute is provided. Sheep usually work well in a chute the first time they are dipped at a vat, but in the case of old ewes that have been dipped several times at the same vat it is often necessary to put them into the vat by hand. The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily. The running chute should be curved to obstruct the view, and the side on which the men work should be tight-boarded. The usual height for the sides of the chute is 40 inches, and the width of the chute 18 to 22 inches, depending on the size of the sheep. Sheep work well uphill but not down an incline; the chutes and alleys, therefore, should be upgrade to the vat. If necessary, elevate the running chute so that it slants upward to the slide board. A small pen should be provided near the entrance to the vat and so arranged that the sheep may see it. This pen, known as a "decoy pen," is filled with sheep to induce the other members of the flock to work toward the vat more readily in their efforts to join those in the pen. The size and arrangement of the corrals will vary necessarily with the topography of the location and the individual ideas or tastes of the owner.

DRAINING PENS.

When a sheep emerges from the vat it carries out a large quantity of dip in the fleece. Most of this dip drains out of the fleece very rapidly, and it is desirable that it be saved and returned to the vat. Draining pens with water-tight floors sloping toward the vat, there-

fore, should be provided. The size will depend upon the size of the plant and the number of sheep to be dipped. The relative size shown in the plans illustrated in figures 14 and 15 may be followed, increasing or decreasing the size of the pens to correspond to the length of the vat. There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or cement and should have catch basins or screening and settling wells into which the dip drains so as to prevent manure and foreign matter from being carried into the vat. Drawings of screenings and settling wells will be found in the plan of the cement dipping plant (fig. 15). In constructing draining pens of cement it is advisable to build the outer walls in the same manner as the foundation for a house, except that they are to be 6 inches thick. The space inside these walls is then filled with gravel to the required height and the floor laid on it. Cement floors should have rough surfaces to prevent slipping. A coat of "pebble dash" over the cement floors will afford a suitable surface for the sheep to stand on, or the cement surface, while soft, may be roughened by means of a stiff broom. The floors of draining pens should slope so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

VATS.

The dipping vat may be constructed of either lumber or cement, the cement vat being preferable. The length of the vat may vary from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where from 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, width at bottom 8 inches and at top 2 feet. Sheep vats usually are constructed so that the top is flush with the top of the ground, and there should be no crosspieces to interfere with the free action of the sheep or of the men working along the vat. As a matter of individual taste, however, the top of the vat may extend from 9 to 18 inches above the ground. Those of the latter kind afford a better opportunity to handle the sheep and can be operated with less effort than those whose top is flush with the ground. If it is desired that the top of the vat should be flush with the ground, it should first be built at least 4 inches above the natural surface of the ground and then dirt or gravel may be filled in, thus securing proper drainage along the sides.

Whenever it is possible to do so the gravity method of draining the old dip out of the vat should be adopted, as otherwise it is necessary to pump or dip it out each time the vat is cleaned. The end of the vat having the drain should be slightly lower than the other end so that all the liquid will drain off.

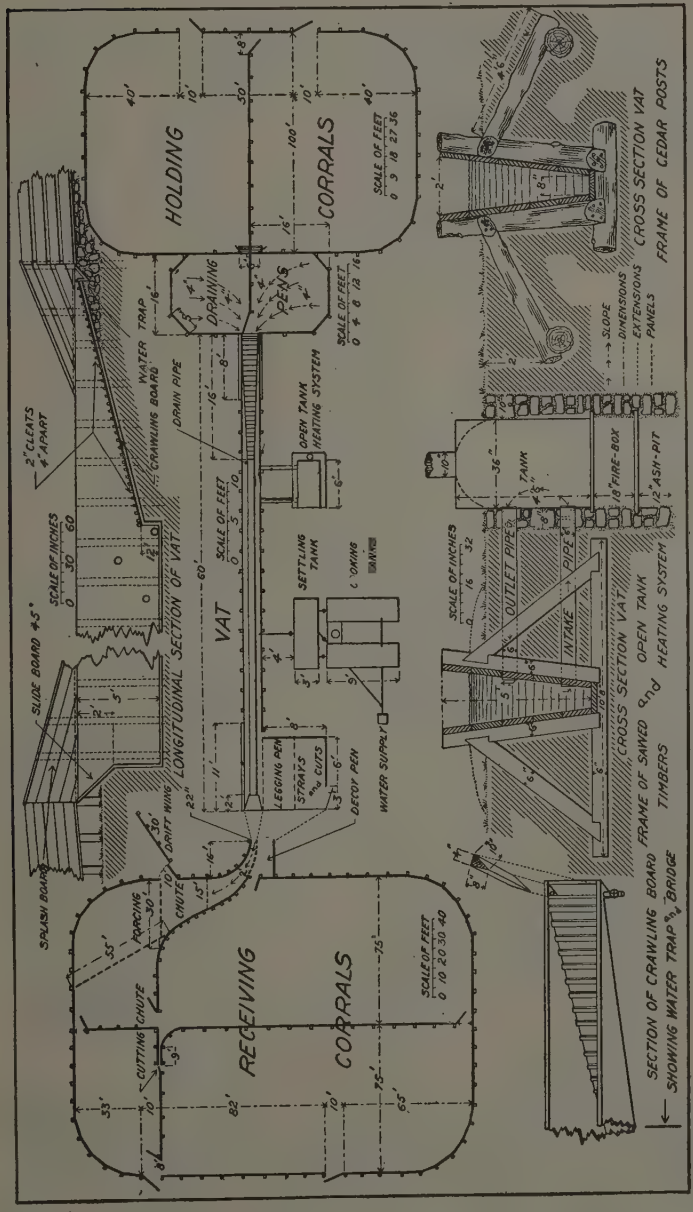

Fig. 14.—Plan of sheep-dipping plant; wooden vat.

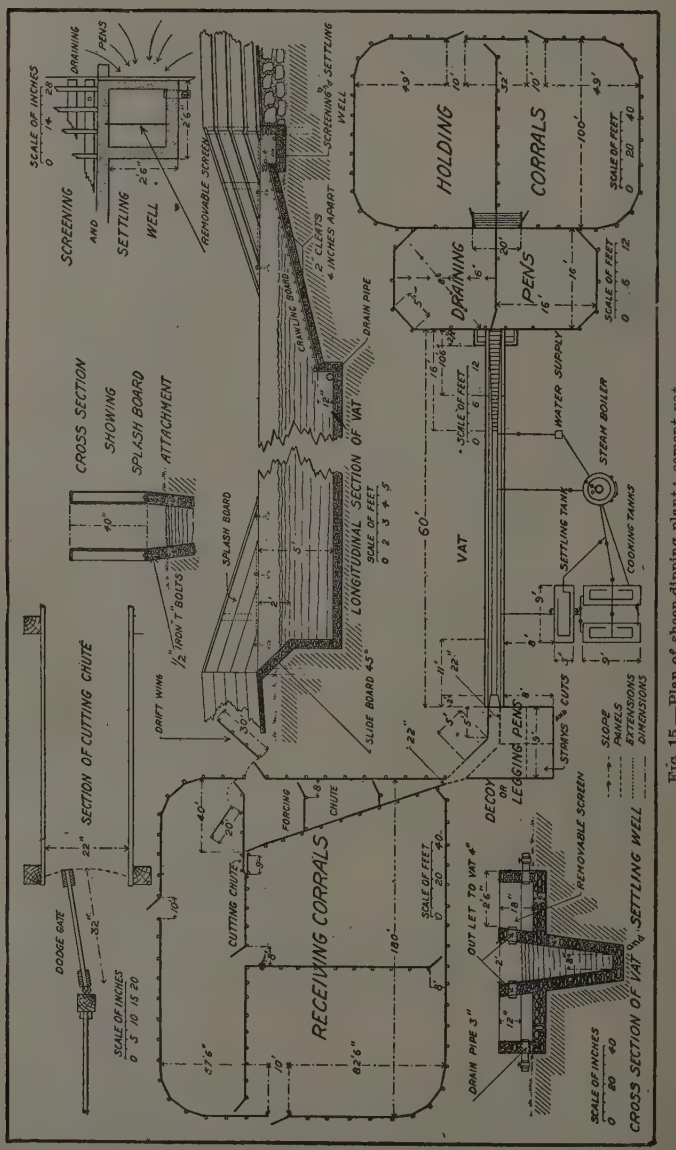

FIG. 15.—Plan of sheep-dipping plant; cement vat.

The slide board into the vat should be set at an angle of 45 degrees and extend from the floor of the chute to at least 4 inches below the dip line; it should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. A space between the slide board and the end of the vat, if large enough for a lamb to lodge in, is a dangerous arrangement. The runway leading out of the vat should not be too steep. The length varies from 8 to 16 feet, the latter being preferable in large vats.

HEATING FACILITIES.

When lime-sulphur dip is used it is necessary to provide cooking tanks. The cooking may be done by steam or in open boilers having a fire box under each. All large plants should have steam boilers of not less than 25 horsepower. The live steam can be piped into the dipping vat and used for maintaining the temperature of the dip and also into the cooking and heating tanks for boiling the dip or heating water. The steam pipes should extend along the floor of the vat at least two-thirds of the length and be provided with openings for the escape of the steam into the dip. The supply pipe from the settling tank should enter the vat above the dip line in order that any leak may be detected easily. The open-tank heating system, if preferred, may be installed instead of the steam boiler.

CARE OF PLANT WHEN NOT IN USE.

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat tends to cause them to bulge inward; this tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats which are allowed to stand empty will dry out, and the lumber will shrink so that the vat will leak when refilled. At the close of dipping operations the vat should be left full of liquid and water added from time to time to restore that lost by evaporation.

A week or 10 days prior to beginning dipping operations the entire plant should be overhauled and put in good condition. Before charging a new vat or one which has stood empty for some time, it should be filled with water to ascertain whether it leaks.

CONSTRUCTION OF DIPPING PLANTS.

Plans for construction of wooden and cement sheep-dipping plants are shown in figures 14 and 15. They are not drawn to a uniform scale, consequently in studying the drawing the scale of each part should be noted. The plants as shown have no superfluous equipment, and the arrangements are as simple as is consistent with efficiency. The size of the plant can be increased or decreased as desired. A differ-

ent corral, chute, and legging pen arrangement is shown with each vat. All these parts are suitable for use with either vat. Cross fences as desired can be added to the corrals. Cutting chutes are shown in both plans, as every large dipping plant should have such a chute equipped with a dodge gate so the lambs may be cut out and dipped separately.

If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as an obstacle to the men working along the vat. There should be no obstructions to the path along both sides of the vat. The pipes can be placed under the ground, or a portable V-shaped trough can be used for conducting liquids into the vat and laid aside when not in use.

THE WOODEN VAT.

As shown in the plans for the wooden vat, one side of the running chute is made of portable panels so they may be shifted and the space converted into a legging pen. Two styles of framing are shown. In the cedar-growing sections the cedar-post frames are preferable because they do not decay rapidly, while the sawed white-pine timbers do. Where hardwood is used instead of white pine the frame timbers need not be so heavy; 4 by 4 inches is heavy enough for framing in hardwood. The frames are set from $2\frac{1}{2}$ to 4 feet apart, depending on the character of the soil and the material used; $2\frac{1}{2}$ feet apart is a safe rule, as the closer the frames are to each other the less tendency there is for the sides of the vat to bulge in between the frames. Two-inch tongue-and-grooved planks should be used in making the vat, and they should be beveled so all joints and seams may be properly calked with oakum or similar material.

The open-tank heating system is shown in the drawings. When this system of heating is used it is not necessary to have settling wells, as the heating tank acts as a settling well. It has an advantage over the old-style coil-heating system in that the pipes are easily cleaned if they become clogged. A water trap is provided for in the exit end of the vat with a bridge to fit into the trap while dipping is being done. When dipping operations are finished for the day the bridge should be removed and the valves of the drainpipes opened so water from the draining pens may not run into the vat.

THE CEMENT VAT.

In the plan for the cement plant the corrals and chute are very conveniently arranged. The portable panels can be shifted to form either a running chute or a legging pen. The settling and screening wells shown also can be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well,

the groove into which the removable screen is to sit should be provided for, as well as the 4-inch openings for drain and outlet pipes.

The trench for a cement vat should be excavated so that the inside dimensions correspond with the outside dimensions of the vat when completed. If the sides of the trench are smooth and reasonably firm they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms. The drain and other pipes shown in the drawing should be placed in the form and should all be threaded and capped so that proper connections may be made. The ½-inch iron bolts and the iron pipe shown in the drawings should be embedded in the cement of the incline for attaching the false floor or crawling board. The floor is made of 1 by 6 inch boards laid lengthwise with cross cleats as shown in drawings. The splashboards at the entrance end of the vat and the guides at the exit end are nailed to 2 by 4 inch scantling bolted to the cement wall, and the bolts should be embedded when the wall is being constructed. Two pairs of bolts should also be embedded for attaching the slide board. Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the cement. They should pass over the top of the vat and down the side in a groove formed in the wall, so they will not come in contact with the sheep or cause annoyance to the men working along the vat.

The walls should be made 6 inches thick, constructed of concrete mixed in the proportion of 1 part cement, 2½ parts sand, and 4 parts broken stone or gravel. This mixture is slushed into forms properly set, and when it approaches dryness the forms are removed and the inside surface of the vat coated with pure cement mixed to about the consistency of cream and applied with a brush. It is important that this coating be well brushed in so as to fill all cavities and form a smooth surface. Finishing coats of sand and cement applied with a trowel after the forms have been removed are liable to crack and scale off.

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